January 28, 1987

To: W.E. Cooper
From: K. Dixon KD
Subject: Safety Documentation

Enclosed are some of the following safety documents that you have requested recently. These include: E706EN012 w/corrections, letter from Dan Burke commenting on the CCI Report No. 593-113, test documentation on the LAC frontal excluder vessel.

xc: NBS

E706 CRYOSYSTEM DESIGN NOTE

E706EN012

TITLE: E706 LAC Dewar Venting

AUTHOR(S): K. DIXON

DATE: August 25, 1986

OBJECTIVE OF NOTE:

This note determines the venting capacity of the existing relief devices on the LAC and also the required capacity per CGA S1.3.5.3.

The calculations assume that the manufacturer's formulas are correct and applicable. Pressure drops assume incompressible flow through inlet piping with the use of the Fanning equation. Saturated argon gas properties were assumed for the inlet condition.

The LAC venting capacity is 20,200 scfm assuming an exit pressure drop no greater than 1 psi. The required capacity is found to be ~~19,800~~ 20,100 scfm.

REVIEWED BY:

James R. Kilmer	11/11/86	[signature]	11 Nov 86
Name	Date	Project Manager	Date

RELIEF SIZING

P_o = 1.21 MAWP = 1.21 (16 psig) = 19.4 psig
= 34.1 psia To = 96.1K = 173°R

$$\left.\frac{P_e}{P_o}\right|_{crit} = \left[\frac{2}{k+1}\right]^{\frac{k}{k-1}} = 0.487$$

$$\left.\frac{P_e}{P_o}\right|_{design} = \frac{14.7}{34.1} = 0.432$$

Since 0.432 < 0.487, Sonic flow

Required Flow Rate per CGA S1.3.5.3

$\dot{V}$ required $Q_a = G_u A^{0.82}$

A = surf area for fire condition
= surf area of insulation *
= $\pi\, d_{cyl}\, L + 2\pi\, r_{head}\, d_{head}$
= ~~(205)(225) + 2π (205)(41.5)~~
= 198,000 in² = ~~1380ft²~~ 1410ft²

$d_{cyl} = d_{LAC} + 2\, t_{insul} = 226$ in
$r_{head} = r_{LAC} + t_{insul} = 216$ in

$$G_u = \frac{6.33 \times 10^5}{LC}\left(\frac{ZT}{M}\right)^{1/2}$$

L = h_{fg} = 154 j/g = 66.2 BTU/hr

* This area actually larger than wetted area

$$j_u = \frac{6.33 \times 10^5}{66.2 \times 377} \left(\frac{173}{40} \right)^{1/2} = 52.7$$

$$\boxed{\dot{V}_{required} = \cancel{19,800}\ 20,100 \text{ SCFM air required flow}}$$

<u>Actual flow w/o Δp included due to piping</u>

$$\dot{V}_{rv} = \frac{6.32\ ACK\ P_1}{\sqrt{MTZ}} \quad \text{Anderson-Greenwood Catalogue}$$

$$= \frac{6.32\ (19.56)(356)(\cancel{9}0.845)(34.1)}{\sqrt{29(520)(1)}}$$

$= 10300$ SCFM

$$\dot{V}_{rd} = \frac{260\ AP_1}{\sqrt{Sp.Gr.\ (T)}} \quad \text{BS\&B Catalogue}$$

$$= \frac{260 \frac{\pi}{4} (6)^2 (34.1)}{\sqrt{520}}$$

$= 11000$ SCFM

$\dot{V}_{tot}$ w/o $\Delta p_L = 21300$ SCFM air

Check Δp in pipe:

worst case is relief piping which is

126" lg sch 40, 6" pipe $\dot{m} = 25.5$ lbm/s

$d_i = 6.065$ in $= 0.505$ ft

$L_p = 10.5$ ft

$K_{inlet} = 0.5$ if pipe is cut flush

$$V = \frac{\dot{m}}{\rho A} \quad \frac{25.5\ \text{lbm/s}}{0.78\text{lbm/ft}^3\ (\pi/4)(.505\text{ft})2} = 152\ \text{ft/s}$$

$$\dot{K} = \sqrt{\lambda RT}$$

$$\approx 577\ \text{ft/s}$$

$M = 0.281$, assume incomp. flow

$$\Delta p = \left[f\,\frac{L}{D} + k\right]\left[\frac{m^2}{A^2\ 2\ \rho g_c}\right]$$

$$R_D = \frac{\rho VD}{\mu} = \frac{(0.780\ \text{lbm/ft}^3)(182\ \text{ft/s})(0.505\ \text{ft})}{0.538 \times 10^{-5}\ \text{lb/ft.s}}$$

$R_D = 9.3 \times 10^6$ F = .015 From Crane Flow of Fluids

$$\Delta p = 0.812\left[\frac{(25.5\ \text{lb}_m/\text{s})^2}{2(0.2\text{ft}^2)^2(.780\text{lb}_m/\text{ft}^3)(32.2\ \frac{\text{ft}}{\text{s}2}\ \frac{\text{lb}_m}{\text{lb}_f})}\right]$$

$$= 263\ \text{psf}$$

$$\boxed{= 1.8\ \text{psi drop}}$$

ALLOWABLE PRESSURE DROP THROUGH EXIT PIPING

- let flow through relief at std conditions with air =

$\dot{V}_{rv}$ = 9800 SCFM

- let flow through rupture disk at std conditions with air =

$\dot{V}_{rd}$ = 10400 SCFM

- let Δp through both inlets to rd angle rv =

Δp_{inlet} = 1.8 psi

$$\dot{m}^{argon}_{rv} = \dot{V}_{rv} \left(\frac{M_{argon}}{M_{air}}\right)^{1/2} \left(\frac{C_{argon}}{C_{air}}\right) \left(\frac{P_{\cancel{2}atm}}{P_2 - \Delta p_{inlet}}\right) \left(\frac{T_{inlet}}{T_2}\right)$$

$$\times \frac{\rho^{sat}_{inlet}\ (lb_m/ft^3)}{60\ (s/min)}$$

$$= 9800 \left(\frac{40}{29}\right)^{1/2} \left(\frac{377}{356}\right)\left(\frac{14.7}{32.3}\right)\left(\frac{173}{520}\right)\left(\frac{0.78}{60}\right)$$

= 24.0 lbm/s Sat argon

$$\dot{m}^{argon}_{rd} = \frac{10400}{9800} (24.0)$$

= 25.4 lbm/s sat argon

$$\Delta p = \left(\frac{fL_e}{D} + k\right)\left(\frac{\dot{m}^2}{2A^2\ \rho g_c}\right)$$

$$\Delta p_{rv} = \frac{(0.31 + 0.5)\ (284)}{144}$$

= 1.60 psi

$$\Delta p_{rd} = \frac{(0.28 + 0.5)\ (321)}{144}$$

= 1.74 psi

$\boxed{\therefore \text{ assumed } \Delta p \text{ is ok}}$

Now check $\dot{V}$ for both reliefs:

$$\dot{V}_{rv} = \frac{6.32\ ACK\ P_1}{\sqrt{MTZ}} \quad \text{Anderson-Greenwood Catalogue}$$

$$= \frac{6.32\ (19.56)(356)(0.845)(32.3)}{\sqrt{(29)(620)(1)}}$$

$$= 9780\ \text{SCFM}$$

$$\dot{V}_{rd} = \frac{260\ AP_1}{\sqrt{SG(T)}} \quad \text{BS \& B Catalogue}$$

$$= \frac{260(\frac{\pi}{4})(6)^2(32.3)}{\sqrt{520}}$$

$$= 10410\ \text{SCFM}$$

$$\dot{V}total = 9780 + 10410$$

$$\boxed{Vtotal = 20200\ \text{SCFM}}$$

$$\left.\frac{P_e}{P_o}\right|_{design} = \frac{14.7 + \varepsilon}{34.1 - 1.8}$$

$$\left.\frac{P_e}{P_o}\right|_{design} \leq \left.\frac{Pe}{Po}\right|_{crit}$$

for sonic flow to exist, $\dot{V} \neq f(P_e)$

$$\frac{14.7 + \varepsilon}{34.1 - 1.7} \leq \left[\frac{2}{k + 1}\right]^{(\frac{k}{k-1})} = 0.487$$

$$14.7 + \varepsilon \leq 0.487\ (34.1 - 1.8)$$

$$\varepsilon \leq 0.487\ (34.1 - 1.8) - 14.7$$

$$\varepsilon \leq 1.03 \text{ psi}$$

$\therefore$ Pressure drop through exit piping should be no greater than 1 psi at full flow conditions.

June 24, 1986

TO: DISTRIBUTION

FROM: Dan Burke, Mechanical Engineer
E-706 SAFETY DOCUMENTATION

SUBJECT: THE CCI REPORT NO.593-113

While there are many points of confusion due to an almost total lack of cited references in the Task Order No.002 R-1, CCI Report No.593-113 on Subcontract No.94362, I am most confused by the vent pipe flow calculations of Section III.B. It would be nice to have clarification of many points within the report, but I feel that the worksheets for Section III.B. should be required. I've done some rough calculations which will demonstrate the reasons why the worksheets will be requested and reviewed critically. The task order does not state methods or even a general analytical approach to the flow of Argon, i.e:

1. Was Argon taken as an idea gas?

2. Was the flow assumed compressible or incompressible? Or

3. Was an incompressible flow assumed over short sections where the pressure change was kept to less than 10% with correction to the density based on stagnation temperature, and the calculation repeated until convergence over each section(Ref.4, Sec.4.5)?

According to Ref.1,4 and 6 or any text book, one rule of thumb to use in picking the proper assumption for compressibility or incompressibility is that the flow can be assumed incompressible if the Mach number remains less than 0.300 or if no large changes in section, fluid properties or stagnation temperature occur over relatively short sections. For example, for a flow rate of m = 100000 lbs/hour at 360 R and one atmosphere, the fluid properties would be:

P = 1 Atmos.		pressure
V = 6.562 cu ft/16m		spec. volume
A = 0.3855 sq ft		duct area
C = 864 ft/sec		sonic velocity

The Mach number would be:

Mach = 100000/3600 x 6.562/.3855/864

Mach = 0.547

and the flow must be assumed compressible.

Another point involves the use of the equation cited by the task order for the friction factor:

$F = 0.046/(Re)^{0.2}$

This equation can be found in Ref.1, and is restricted to Reynolds Number(Re) between 5000 and 200000. When this Reynolds number limitation is ignored, the following comparison can be made:

at 16 PSIG = 30.7 PSIA
for M = 45000 lb/hour of sat.fluid
for a diameter, d = 8.407 inch
for spec.vol, VG = 1.4109 cu ft/lbm
vislocity, visc = 5.3081E-6 lb/ft-sec

Re = 48/Pi x m/3600/visc/d

<u>Re = 4.3E6</u>

at 1 Atmos and 360 R, m = 45000 lb/hour

<u>Re = 2.1E6</u>

Obviously, the use of the cited equation is not valid - if it was actually used. This equation would lead to values of the friction factor of 0.002 to .0025. I've never seen a chart which included friction factors this low!

According to Ref.3,4,6 or any text for smooth tubes, the friction factor should be, for Reynolds numbe,rs greater than 2E6, F = 0.015. For an incompressible flow, the error may lead to calculations of flow rate that are almost three times too large. For a compressible flow, the error may cause flow rate errors even greater than three times.

The AGCO method, Ref.2-Sec.5, applies to compressible flows at pressures less than or equal to 15 psig. According to AGCO, the method has been tested again and again and found adequate. I have made some rough calculations which, for one of the calculations, assumes a 16 PSIG not 15 PSIG inlet pressure. Use of 16 PSIG will, according to AGCO, induce some error, but not a substantial error when used in comparison to the values cited in the task order. These calculations do not include the <u>flow rate limiting</u> effects of heat transfer, Ref.6 or any text.

The resistance in the relief valve(RV) circuit piping is, Ref.2,3,4, and 6:

L/D + KIN = 126.38/6.407 + .5/.015

KIN = inlet contraction loss = 0.5, Ref.3
F = Friction factor = 0.015, Ref.3,4,6

Leq 1 = 339.947 in = 28.33 ft.

From Ref.2, the series 93 RV has an L/D = 197, so

Leq 2 = 6.407(197)
Leq 2 = 1262.18 in = 105.18 ft.

Converting the 8 inch discharge header to 6 inch, Ref.2,3,4,6 and including KOUT = 1.0:

Leq 3 = $312 \times (6.407/8.407)^5 + 1.0/.015$
KOUT = Exit expansion loss = 1.0
Leq 3 = 507.37 inch = 42.28 ft.

TOTAL = 2109.37 inch = 175.78 ft. for the RV circuit.

According to Ref.7, the L/D for the burst disk(BD) is L/D = 75. The equivalent length for the BD is then

Leq 1 = 339.947 inch = 28.33 ft
Leq 2 = 480.425 inch = 40.044 ft
Leq 3 = 507.37 inch = 42.28 ft

TOTAL = 1327.842 inch = 110.654 ft for the BD Circuit

From Ref.2, the pressure which controls the flow rate can be found from:

P2 = P1 - P1 x Leq 1/Total
P3 = P1 - P1 x (Leq 1 + Leq 2)/Total
P2 = RV or BD inlet, PSIG
P3 = RV or BD outlet, PSIG
P1 = Dewar or Tank pressure, PSIG

RV FLOW PROPERTIES

The pressures given by the above equations and the satuated Argon properties are tabulated as follows:

16 PSIG DEWAR

P2 = 12.583 PSIG = 27.273 PSIA RV Inlet

T2 = 168.419 R
V2 = 1.5733 cu ft/lb
C2 = 572.588 ft/sec sonic velocity
VISC2 = 5.231E-6 lb/ft-sec
K2 = 1.756 spec. heat ratio

P3 = 3.6078 PSIG = 18.2978 PSIA RV Outlet

T2 = 160.9266 R
V3 = 2.2697 cu ft/lb
C3 = 563.775 ft/sec sonic velocity
VISC3 = 4.992E-6 lb/ft-sec
K3 = 1.724 spec. heat ratio

12.5 PSIG DEWAR

P2 = 10.4856 PSIG = 25.1756 PSIA RV Inlet

T2 = 166.8576 R
V2 = 1.6934 cu ft/lb
C2 = 570.842 ft/sec sonic velocity
VISC2 = 5.181E-6 lb/ft-sec
K2 = 1.741 spec. heat ratio

P3 = 3.0065 PSIG = 17.6965 PSIA RV Outlet

T3 = 160.3315 R
V3 = 2.3403 cu ft/lb
C3 = 563.028 ft/sec sonic velocity
VISC3 = 4.973E-6 lb/ft-sec
K3 = 1.722 spec. heat ratio

BD FLOW PROPERTIES

16 PSIG DEWAR

P2 = 11.159 PSIG = 25.849 PSIA BD Inlet

T2 = 167.37 R
V2 = 1.653 cu ft/lb
C2 = 571.42 ft/sec sonic velocity
VISC2 = 5.197E-6 lb/ft-sec
K2 = 1.742 spec. heat ratio

P3 = 5.7315 PSIG = 20.422 PSIA BD Outlet

T3 = 162.917 R
V3 = 2.0522 cu ft/lb
C3 = 566.222 ft/sec sonic velocity
VISC3 = 5.0555E-6 lb/ft-sec
K3 = 1.729 spec. heat ratio

12.5 PSIG DEWAR

P2 = 9.300 PSIG = 24.00 PSIA BD Inlet

T2 = 165.9391 R
V2 = 1.7695 cu ft/lb
C2 = 569.792 ft/sec sonic velocity
VISC2 = 5.151E-6 lb/ft-sec
K2 = 1.738 spec heat ratio

P3 = 4.776 PSIG = 19.466 PSIA BD Outlet

T3 = 162.04 R
V3 = 2.1445 cu ft/lb
C3 = 565.155 ft/sec
VISC3 = 5.027E-6 lb/ft-sec
K3 = 1.726 spec heat ratio

The flow rates per Ref.8,9 are:

16 PSIG DEWAR, SERIES 93 RV

P = 27.273 PSIA	P/PE = 0.67091
PE = 18.2978 PSIA	PCRIT= 0.47485
F = 0.38349	NOZP = 22.549 PSIA

SUBSONIC FLOW

m = 19.610 lb/sec Argon
m = 70596 lb/hour Argon

16 PSIG DEWAR, 6 INCH BD

P = 25.8499 PSIA   P/PE = 0.79005
PE = 20.422 PSIA   PCRIT = 0.47673

SUBSONIC FLOW

m = 19.170 lb/sec Argon
m = 19012 lb/hour Argon

TOTAL: 139608 lb/hour Argon

12.5 PSIG DEWAR SERIES 93 RV

P = 25.1756 PSIA   PE/P = 0.70292
PE = 17.6965 PSIA   PCRIT = 0.47687
F = 0.36789   NOZP = 21.224 PSIA

SUBSONIC FLOW

m = 17.421 lb/sec Argon
m = 62716 lb/hour Argon

12.5 PSIG DEWAR 6 INCH BD

P = 24.000 PSIA   PE/P = 0.81108
PE = 19.466 PSIA   PCRIT = 0.47727

SUBSONIC FLOW

m = 17.128 lb/sec Argon
m = 61661 lb/hour Argon

TOTAL: 124377 LB/HOUR ARGON

Comparison of the results to those reported by task order:

16 PSIG DEWAR, T100K

RV, Task order ≐ 80000 lb/hour
RV, as calculated = 70596 lb/hour, 11.8% difference
BD, Task order ≐ 200000 lb/hour
BD, as calculated = 69012 lb/hour, 65.5% difference

12.5 PSIG DEWAR, T 100K

RV, Task Order ≐68000 lb/hour
RV, as calculated = 62716 lb/hour, 7.8% difference
BD, Task Order ≐ 140000 lb/hour

BD, as calculated = 61661 lb/hour, 55.9% difference

The above differences cannot be explained on a variation in the specific heat ratio since the warmer the gas, the lower the ratio, the lower the flow. Also note that the comparison is made using task order values which are cold, assuming almost no heat transfer.

I must repeat that the influence of heat transfer is to reduce the flow carrying capacity, Ref.1,5,6, any text. Therefore, how can the values reported by the task order which are supposed to be influenced by heat transfer effects be higher, in all cases, with values that are calculated without the influence of heat transfer?

The maximum possible flow through the burst disk can be found from Ref.9. This maximum flow will exist if sonic flow is occurring in the burst disk throat. It is a little difficult to décide what inlet conditions to use, but the task order states that the discharge temperature of the Argon will be about 180°R; this is very nearly 100°K, where, for a 16 PSIG dewar, the flow is said to be 200000 lb/hour Argon. For 180 R and 200000 lb/hour, the pressure required to drive this flow rate is 65.92 PSIA. However, Argon exists only as subcooled fluid at 65.92 PSIA and 180°R. If 187.94°R is used as the inlet temperature, then the driving pressure must be 63.83 PSIA. If 540°R Argon is the burst disk inlet temperature, the driving pressure must be 111.5 PSIA. Finally, if the fluid enters the burst disk as saturated vapor at 30.7 PSIA, the maximum possible flow would only be 99485 lb/hour Argon. Obviously, the warmer the Argon, the lower the capacity and 200000 lb/hour does not fit any reasonable set of fluid properties.

DB:cf
Filename: dbcci

Distribution: R.Smith, K.Dixon, R.Dachniskyj

REFERENCE

1. Heat Transmission, William H. McAdams, Third edition, McGraw-Hill Book Co.

2. AGCO Report No.2-0175-128, Determination of Flow Losses in Inlet and Discharge Header Associated with Safety Relief Falves, esp. Section 5.

3. Crane Technical Bulletin No.410

4. Applied Fluid Dynamics Handbook, Blevins, Van Nostrand Reinhold, 1984.

5. Journal of Applied Mechanics, Vol.14, No.1, Transactions of the American Society of Mechanical Engineers, the paper, cited by Ref.1, "The Mechanics and Thermodynamics of One-Dimensional Gas Flow".

6. Introduction to Fluid Mechanics, Fox and McDonald, Wiley, 1973, esp. Chapters 9 and 10.

7. BS&B Safety Systems, BS&B Rupture disks, Sizing and Specifying, Cat.77-1005, Section B.

8. AGCO Series 90 Safety-Relief Valves, Cat. 1900.

9. Fike Rupture Disk Assemblies, Cat.7380.

DB:cf
6/24/86

RADIOGRAPHY, ULTRASONICS, MAGNETIC PARTICLE, LIQUID PENETRANT
SURVEILLANCE INSPECTION AND HELIUM LEAK TESTING SERVICES
HOISTING DEVICES SAFETY CERTIFICATION PROGRAM

A & I Inspection Services Limited

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978 Bishop Street N.
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Phone (519) 653-5791

1061 Barton Street
THUNDER BAY, ONTARIO
P7B 5N3
Phone (807) 622-2101

HELIUM LEAK TEST CERTIFICATE

CLIENT: UNITECH

P.O.: ______________ CUSTOMER P.O.: 4118

DESCRIPTION OF PIECES - (include serial numbers) ARGON FILLER VESSEL
S/N 41

SPECIFICATION: CUSTOMERS SENSITIVITY: 10^{-5}

INSTRUMENT: VARIAN 936-40 TEST PRESSURE: 15 P.S.I external
½ HR. SOAK TIME.

Report No.	Date of Test	Our Job Order no	Inspector
1	OCT 6/86	7251	Ron McLean.

RESULTS OF TEST:

FOUR LEAKS WERE FOUND
GREATER THAN 10^{-5}. UNACCEPTABLE ACCORDING
TO CUSTOMER SPECIFICATIONS.

Ron McLean.
TECHNICIAN:

[signature]
WITNESSED BY:

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1081 Barton Street
THUNDER BAY, ONTARIO
P7B 5N3
Phone (807) 622-2101

HELIUM LEAK TEST CERTIFICATE

CLIENT: UNITECH

P.O.: ______ CUSTOMER P.O.: 4115

DESCRIPTION OF PIECES - (include serial numbers) ARGON FILLER VESSEL SN. 011

SPECIFICATION: CUSTOMERS SENSITIVITY: 10^{-9}

INSTRUMENT: VARIAN 936 40 TEST PRESSURE: 15 P.S.I. 1/2 HR. SOAK TIME

Report No.	Date of Test	Our Job Order no	Inspector
2	OCT 7/86	2251	Ron McClain

RESULTS OF TEST:

ALL FOUR LEAKS WERE REPAIRED AND FOUND EXCEPTABLE TO THE SENSITIVITY OF 10^{-9}.

TECHNICIAN:

WITNESSED BY:

UNITECH
MANUFACTURING
INCORPORATED

35 RIDGEWAY CIRCLE, P. O. BOX 10
WOODSTOCK, ONT., CANADA N4S 7W5

TEL. (519) 539-9886
TELEX: 064-7262

NON-DESTRUCTIVE

TEST REPORT

TO:

Part Number 7498-D, Part Name Argon Filter Vessel

Serial Number 11-1, has been welded and inspected using the procedures outlined in your specification 080-100W. This unit has been Hydrostatic Tested, Dye Penetrant Tested and X-Rayed in accordance with the applicable procedures and has been accepted as listed below.

Hydrostatic Inspection at 134 P.S.I.	Date 10-4-86	Approved by B. S.
X-Ray Inspection	Date ______	Approved by ______
Dye Penetrant Inspection	Date 10-9-86	Approved by B. S.

SNT-TCA-1 Level III

CGSB Level II

UNITECH MANUFACTURING INCORPORATED

35 RIDGEWAY CIRCLE, P. O. BOX 10 W...STOCK, ONT., CANADA N4S 7W5
TEL. (519) 539-8666 TELEX: 064-7262

DETAILED INSPECTION REPORT

...AR. NUMBER	W.O.# / P.O.#	QTY.	DATE	CUSTOMER
7499-D	8244 F377480	1	10-7-86	U of R

...ART NAME	SERIAL #
Argon Filler Vessel	U-1

...O.	BLUE PRINT DIMENSION	TOLERANCE	ACTUAL DIMENSION	COMMENTS
Item 13	2 1/4	± 1/16	2.247	
	1 3/8	± 1/16	1.372	
	1 1/8	± 1/16	1 5/32	
	9/64		.140	
	1"-8 Thread		OK	
	2 1/2		2.512	
	1 1/2		1.506	
	4 3/4		4.772	
	3/4		.763	
Item 12	1/4		254 / 256	
	1 1/16		1.071 / 1.065	
	2 1/4		2.248	
Item 14	1/4		249 / 255	
	13/16		815	
	2 1/4		2.247	
Item 6	18" x 2	± .002	36" 1/16	
	44"	± 1/16	OK	
	5"	± 1/16	OK	
	2"	± 1/16	OK	
Item 11	6"	± 1/16	6"	
	6"	± 1/16	5" 7/16	
	2"	± 1/16	2"	
	3"	± 1/16	3"	
	1/2	± 1/16	OK	

[illegible signature]

UNITECH MANUFACTURING INCORPORATED
35 RIDGEWAY CIRCLE, P. O. BOX 10 WOODSTOCK, ONT., CANADA N4S 7W5
TEL. (519) 539-8886 TELEX. 064-7262

DETAILED INSPECTION REPORT

PART NUMBER	W.O.# / P.O.#	QTY.	DATE	CUSTOMER
11499-D		1	10-7-80	U of R

PART NAME	SERIAL #
Argon Filler Vessel	U-1

NO.	BLUE PRINT DIMENSION	TOLERANCE	ACTUAL DIMENSION	COMMENTS
1	119 3/4	± 1/8	119 7/8 - 120"	
2	22" x 2	± 1/16	44 1/8	
3	17 3/4	± 1/16	✓ ok	Top View
4	~~4~~" 9"	± 1/16	9"	
5	3/8	± 1/16	✓ ok	
6	5"	± 1/16	5 1/16	
7	5' 8 9/16	± 1/8	5' 8 9/16	ok'd per Tom Harland
8	48"	± 1/16	48	
9	48	± 1/16	48	Elevation View
10	29 3/8	± 1/16	29 5/8	
11	10'-5 3/8"	± 1/8	10' 5 3/8	
12	6"	± 1/16	6 1/8"	
13	2"	± 1/16	~~3~~ 2"	
14	10' 6 1/8	± 1/8	10' 6"	
15	11' 5 1/8	± 1/8	11' 5"	
16	26 5/16"	± 1/8	26 1/4"	
17	13"	± 1/16	13"	
18	6"	± 1/16	6" - 6 1/16"	
19	3"	± 1/16	✓ ok	Bottom View
20	1 1/4	± 1/16	1 3/16	
21	13 3/8	± 1/16	13 3/8 - 13 7/16	
22	22" x 2	± 1/16	44"	
Item 23	3/4 10 x 2"		ok	
	with 1/8 hole		ok	

INSPECTED BY [signature]